37. 3D LASER SCANNING DOCUMENTATION

A. Introduction

There is a need to document the spatial relationships of items or areas within a crime scene. While this can be accomplished in a variety of ways, the most comprehensive method is through the use of three-dimensional (3D) laser scanners. The 3D laser scanners capture detailed three-dimensional data sets of complex environments and large-scale scenes in a matter of minutes. There are two 3D laser scanning devices utilized by the Crime Scene Response Section (CSR) to accomplish this task, the FARO Focus S150 Laser Scanner and the FARO Freestyle 2 Handheld Laser Scanner.

The FARO Focus Laser Scanner is a high-speed three-dimensional laser scanner used to capture detailed measurements and documentation of the area scanned. The FARO Laser Scanner uses laser technology to produce exceedingly detailed three-dimensional images of complex environments and geometries in only a few minutes. The resulting images are an assembly of millions of 3D measurement points.

The Freestyle 2 scanner enables you to record the dimensions and colors of objects and environments in three dimensions. To accomplish this, you move the handset along or around the object of interest. As you move the handset, three integrated sensors record what they capture. The Freestyle 2 projects a pattern of small infrared dots on the surface of the object. The two infrared cameras take photographs of this pattern. The 3D coordinates of the infrared dots are then calculated using a mathematical method called triangulation. The recorded points are then used to create a colored, 3D model of the captured object or environment.

B. Equipment

(1) FARO Focus scanner S150

- (a) Scanner head
- (b) Scanner tripod
- (c) SD card
- (d) NIST Scale Bar
- (e) Spheres
  - i. Target spheres- 200mm spheres
  - ii. Trajectory spheres- 70mm spheres
- (f) Markers
  - i. Checkerboards
  - ii. RAD (Ringed Automatically Detected) Markers

(g) Dell Precision 7550 Laptop

(h) Scene software dongle

(i) Power block battery

(2) FARO Freestyle 2 Handheld Scanner

(a) Scanner handset

(b) Mobile PC with carrying strap

(c) Smartphone

(d) Markers

i. RAD (Ringed Automatically Detected) Markers

(e) Reference plate

(f) Power block battery

C. Procedure

(1) Procedures for operating the 3D laser scanners, as well as, processing the data, require considerable training and experience. Only those who have successfully completed the requisite training as well as a competency test and have been authorized by the LSB Quality Manager may utilize the equipment. It is strongly recommended that those who have been trained have regular practice using the 3D laser scanners.

(2) The scanners will be utilized when it is in the best interest of the investigation that detailed measurements and capture of the overall detail at the crime scene needs to be obtained. Types of crime scenes that the scanner may be utilized on include Homicides, Officer Involved Shootings, Death Investigations, or any other high-profile scene where detailed capture of the crime scene is required.

(3) Due to the nature of utilizing 3D scanning devices there should be discussions with the investigative personnel at the scene to ensure all relevant data is captured while not interfering with the processing of the crime scene for physical evidence.

(4) Processing of all fragile evidence should occur prior to beginning the 3D scanning process. This could include swabbing for biological evidence, processing for latent fingerprint evidence, possible trace evidence collection, etc. to ensure no deleterious loss of evidence at the crime scene.

(5) The documentation of the use of the FARO scanners will be identified in the operator's official notes pages and will include the following:

(a) IR number

(b) CSR Scanner Device number

(c) SD card number

(d) Date scans completed

(e) Locations scanned

(f) Number of scans completed

(g) Site Sketch

(h) Disposition of the data obtained

(6) The Scene Assist or Vehicle Examination Assist report will have a statement indicating the locations that were scanned related to the specific IR number and that specific measurements can be obtained through the Scene2Go project that will be created from the data. An example of the verbiage for the report is below.

(a) I utilized the FARO Focus S150 (and/or Freestyle 2) Laser Scanner on scene. I scanned the (**areas scanned in the scene**). I obtained (**number of scans obtained**) scans from the scene. Measurement data of the scanned areas at the scene can be obtained through a Scene2Go project that will be created from the scans obtained.

(7) A separate Diagram report will indicate that a Scene2Go project and 3D point cloud data was created and indicate the following information within the report:

(a) Original scan date and location

(b) Description of what was created (3D point cloud, Scene2Go project, Overview map, etc.)

(c) Date when the Scene2Go and 3D point cloud data were completed

(d) Who completed the scanning, processing, and creation of the data

(e) Location of the saved RAW data (file location that can be obtained from the Evidence barcode that is generated in RMS)

(f) Example of verbiage for report:

- A (A Scene2Go project and the 3D point cloud data was created on (**Date 3D data was complete) from the scans captured at (**location of scans**) on (**Date original scans captured**). The scans were captured and processed by (**CSS who completed**) and the RAW scan data is located on the secured server at (**file location info**).

(8) These procedures are base guidelines for operating the scanners. For detailed information related to specific functions within the scanners the individual scanner user manual should be referenced.

(9) Focus S150 Operation

(a) Scanner Set-up

- Set up the tripod

- The scanner head should be removed from the carrying case, ensuring the gray foam is removed from the mirror of the scanner head.
- The scanner head will be placed and secured to the tripod. The tripod should be stable, and level and the tripod feet secured on the surface.
- A site sketch will be created in order to determine the proper parameters related to scanner placement within the scene and to ensure full coverage of the scene will be accomplished. A site sketch is simply a rough hand drawn sketch of the scene identifying placement of the scanners and targets, if utilized, as well as allows for the individual scanning parameters of each scan to be recorded.
- Place any markers or spheres throughout the scene, if necessary. Markers and spheres will only be necessary if a minimum of thirty (30) percent overlap of scan positions cannot be obtained. However, it is recommended that forty (40) percent overlap between scans be obtained as it allows for better registration of the scans.
- If targets are utilized, then a minimum of three (3) similar targets (two if using sensor data, such as an inclinometer) will be placed within the scene that can be visualized by two (2) scan positions. Arrange targets so there is a clear line of sight from the scanner to the targets. Arrange targets in unique patterns in three dimensions by varying the height and spacing of the targets. Do not move the targets during the scanning process in any given area.

    i. Checkerboard/Marker Targets

        1. The angle of incidence between the laser beam and the checkerboard/marker reference should not be less than 45°.
        2. Depending on the chosen scanning resolution, the automatic detection of checkerboard references becomes unreliable beyond a certain distance to the scanner. (e.g. when using checkerboard references and scanning with a resolution of 1/4, the distance to the scanner should not be greater than 30 feet.)
        3. The distance between the scanner and the references should not be smaller than 3 feet.
        4. The checkerboard/marker target should not be rotated by 45° in relation to the scanner's axis.
        5. The checkerboard/marker reference should not be attached to a curved surface.
        6. Print paper checkerboard references with laser printers only.

    ii. Spheres

        1. The spheres should be completely visible in the scan. Make sure that they are not partly obscured by other objects.

2. Depending on the chosen scanning resolution, the automatic detection of sphere references becomes unreliable beyond a certain distance to the scanner. Below is a guide for maximum distance of the various size spheres.

	70 mm Sphere		140 mm Sphere		200 mm Sphere	
	Maximum Distance					
Resolution	ft	m	ft	m	ft	m
1/1	116	35	232	71	331	101
1/2	65	20	129	39	184	56
1/4	32	10	63	19	90	27
1/5	23	7	45	14	64	20
1/8	16	5	32	10	46	14
1/10	13	4	25	8	36	11
1/32	8	2	15	5	21	6

- The NIST certified scale bar will be placed in the first and last scan completed at the scene to provide a reference for measurement accuracy.
- Insert the battery into the scanner with the label side up.
- Insert the SD card that is in the scanner carrying case.
- Turn on the scanner by long pressing the power button on top of the scanner head until the blue light is illuminated.

(b) Scanner Operation

- Format the SD card in the scanner. Only one project per SD card, multiple projects should not be created on one SD card.
- Check the inclinometer on the scanner to ensure that the scanner is properly leveled and will be able to produce accurate scans of the area. The inclinometer should not be indicating yellow or red circles as this would indicate that the instrument is not leveled properly, adjustments to the tripod would be needed to level the instrument.

- Create a new scan project through the Manage>Project/Clusters screen on the scanner interface.
    i. Select “Default Project” and then select “Duplicate”.
    ii. The copied “Default Project” will be selected and the information edited related to the scan to be completed.
    iii. “Project Name” will be the IR number for the incident being scanned followed by underscore and the scan operator’s serial number.
        1. Example: 202100001234567_A1234
    iv. “Parent Project” will indicate “No Parent Project”.
    v. “File Base Name” will be the address of the location being scanned. Additional details can be added onto the location to indicate specific areas scanned within a location (e.g. 621 W. Washington St.- Basement- CSR Office).
    vi. “Initial Scan No.” will indicate “1” as the starting scan number.
- Select the scan parameters for the scans being completed through the Parameters screen on the scanner interface
    i. A profile can be selected based upon the area being scanned, Indoor or Outdoor, as well as overall distance being scanned, <10m or >10m. Below are the pre-defined profiles:

Profile	Quality	Resolution	GPS	Net Scan Duration (hh:mm:ss)	MPts*	Scan File Size (mb)
Indoor...10m	3X	1/8	OFF	04:08	10.9	98
Indoor 10m...	4X	1/5	OFF	07:49	28.0	151
Indoor HDR	4X	1/5	OFF	10:09	28.0	273
Outdoor...20m	4X	1/5	ON	07:49	28.0	151
Outdoor 20m...	4X	1/4	ON	10:24	43.7	200
Outdoor HDR	4X	1/4	ON	12:44	43.7	322
Preview	4X	1/16	ON	1:03	2.7	12
Object HD	6X	1/2	ON	117.46	174.8	2246
Outdoor: Far Distances	4X	1/4	ON	10:24	43.7	200

* resulting scan size in megapoints (MPts).

    ii. The resolution and quality of the scans should be selected based on the area being scanned as well as the detail needed for the current scan being completed.
    iii. As a standard, 1/5 Resolution and 3x Quality should be used for indoor scans and 1/4 Resolution and 3x Quality for outdoor scans. Depending on the needs of the scan being completed these numbers may need to

be adjusted with a larger Resolution needed for higher detail scans or a lower Quality when time is a concern regarding the scans.

iv. Choose a Resolution setting based on the level of detail needed, the distance to the object of interest, and the distance to the targets. Resolution is shown as a fraction and ranges from 1/1 to 1/32.

v. Generally, follow these guidelines:

1. 1/1 or 1/2 – Objects and small areas
2. 1/4 or 1/5 – Outdoors and large, indoor spaces
3. 1/8 or 1/10 – Indoors and small, outdoor spaces

vi. Choose a Quality setting based on environmental conditions. Increase the Quality setting in adverse scanning conditions, and decrease it if conditions are good, time is a factor, or error tolerances are larger. The Quality setting is shown as a number followed by an X. The Quality settings that are available depend on the selected Resolution setting.

1. Generally, follow these guidelines:

a. 2x – No dark objects in large distance and requirement for short scan time.

b. 3x – Normal for indoors and outdoors

c. 4x – Normal for large distance

d. >4x - Very dark objects, reflective

vii. Due to the increase in error rate as the scan distance increases, scan locations should be within approximately 30 ft. of each location. If smaller detail is needed to be captured, such as trajectory rods, the scan locations should be closer to the objects of interest.

viii. The “Scan with Color” function should be enabled for most scans. Scans outdoors at night may not need to be scanned in color.

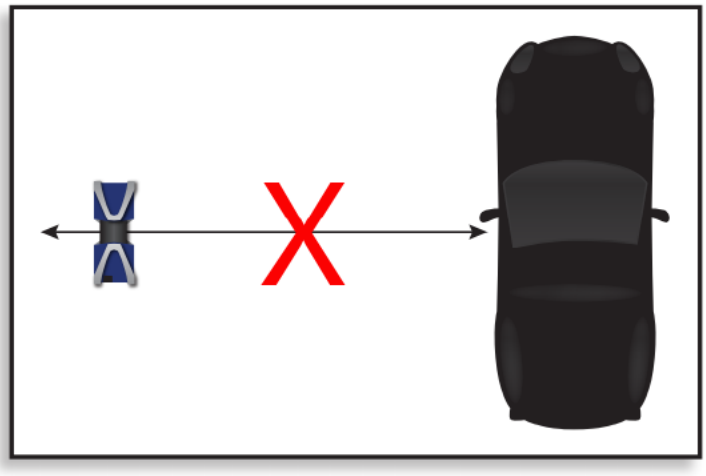
ix. Check to ensure all the sensors are on with the exception of the “GPS” sensor as this sensor would be off if scanning indoor locations.

x. The “Color Settings” parameter can be adjusted based on the lighting at the scene to ensure properly exposed photos are captured with the scanner.

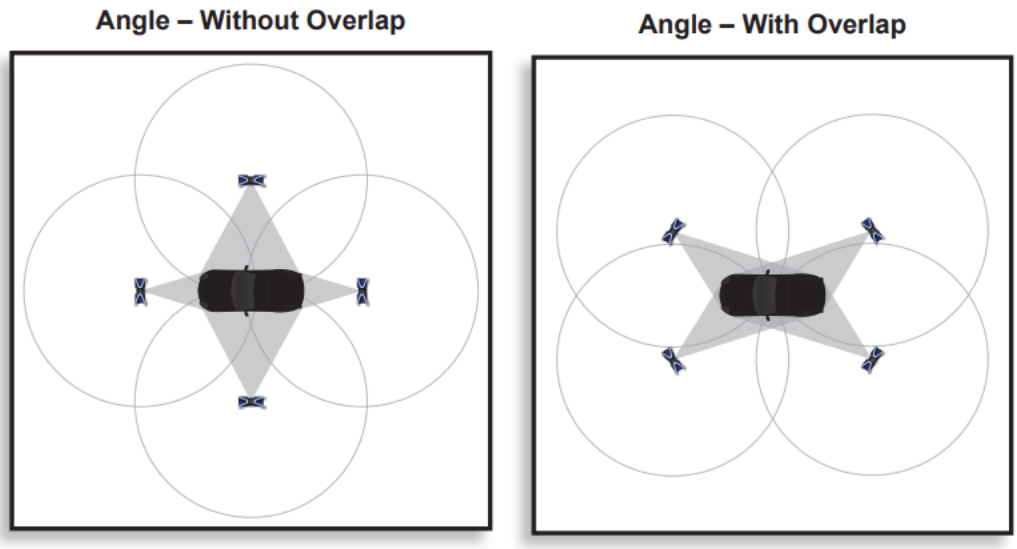
- Select the Manage>Operators screen on the scanner interface to either select or add the operator utilizing the scanner.
- It is important to ensure that personnel at the scene are removed from the scanning area while the scanner is in operation.
- Avoid positioning the scanner so that the start/stop point is on the object of interest or an artificial target. The start/stop line or seam should face the area of least interest. A simple rule of thumb is to make sure you are facing the object of

interest when using the scanner touch screen, which is located on the side of the scanner.

Bisecting the Object of Interest



- Scanning in a logical order will make registration much easier. Circling an object of interest or progressing linearly through a structure will make it easier to keep track of and register scans. The harder it is to follow the scan order on a sketch of the project area, the harder it will be to register the scans later.
- Prior to scanning ensure evidence placards are positioned so that they face towards the scanner's position in order to better identify the individually numbered/lettered items at a crime scene. The placards can still be placed North facing for general crime scene photography of the items and then should be moved for scanning purposes.
- Start the scan by pressing the large blue circle on the main scanner interface screen. The timeframe associated with the scan will be displayed on the scanner interface screen.
- The scanner can be operated remotely using a tablet or smartphone, if applicable. For details on how to operate the scanner through the smartphone interface refer to the Focus scanner user manual.
- Once a scan is complete, preview the scan data to ensure proper data capture before moving the scanner to the next scanning position
- Continue scanning the scene ensuring multiple overlapping scans have been completed as well as appropriate scan coverage of items/areas of interest. Multiple scans captured from different angles provide the most complete three-dimensional image. Selecting proper angles can reduce the number of required scans. Position the scanner at angles to the object of interest that will give you the best line of sight for capturing the necessary details and ensure that scans contain overlapping areas.



- Scan areas should contain unique natural targets to help register the scans. Keep in mind that a full 360° scan may not be necessary every time, depending on the object of interest. Be sure to scan transition areas like doorways to aid registration.
- On-site registration can be completed at the scene and enables the scan data, whether it be from a single scan or multiple scans in process simultaneously, to be wirelessly transmitted directly to an on-site PC and automatically aligned. For specific details on how to complete On-site registration refer to the Focus user manual.
- If on-site registration is not completed, a best practice would be to transfer, process, and register groupings of scans completed at the scene on the Faro laptop computer, in order to establish that all pertinent areas of the crime scene have been captured.
- When scanning vehicles specifically, there should be a minimum of six (6) scans of a vehicle that is not black in color. For shiny dark colored vehicles or vehicles with highly reflective surfaces (e.g. police vehicle reflector decals) there should be eight (8) scans.
- When utilizing the scanner troublesome conditions/surfaces may arise. The following are some recommendations to adjust for these conditions/surfaces:
    i. Rain - Decrease resolution to reduce the number of droplets scanned and increase quality to confirm measurement data. Also, the scanner head should be covered to avoid continuous rain droplets.
    ii. Fog - Increase resolution to 1/4 or 1/3 and use 3x, 4x quality.
    iii. High Winds - Lower tripod height and use 8-to-10-pound sandbags to steady the tripod. Caution: Do not leave scanner unattended in high winds.

iv. Heat - If operating in strong direct sunlight or temperatures over 104°F, a heat protection cover should be used to avoid overheating the unit, protect the scanner and extend operation time. If the scanner overheats, turn it off, eject the SD card and power block battery, and leave in a cool, ventilated, and shaded area. Do not enclose the scanner into the carrying case when the system has overheated.

v. Bright – Bright surfaces can cause an increase in scan noise and loss of measurement data. Increasing scan quality will help reduce the impact of these surfaces. In more intense situations, try covering the surface with masking tape or painter's tape.

vi. Reflective – Mirrors and other highly reflective surfaces can make scanning challenging. Covering these surfaces with brown paper or tape can minimize their impact.

vii. Glass – As light passes through glass, its speed changes. Scanning through glass will lower the reliability of measurements and should be avoided.

viii. Water – Water refracts light too much to return a reliable scan result and should be avoided.

ix. Extremely Hot Surfaces – FARO scanners operate in infrared light. So, beyond the temperature of the target, what matters most is the luminance, or how much light within infrared spectrum it will emit. All items emit IR, and the amount of IR they emit increases as its temperature increases. Extremely hot items (in excess of several hundred degrees Fahrenheit) will tend to emit more IR than they will reflect. At these extreme temperatures it is unlikely that all the laser power emitted from the scanner will reflect and return. This condition can result in missing and inaccurate scan data. In general, it is not recommended to scan any objects that are hotter than 932°F, as the results are not predictable.

- Once the scans have been completed the SD card will be removed from the scanner, after ensuring that the scanner is not writing to the SD card and is in the off position before removing the SD card. The SD card data should then be transferred to the Faro laptop in order to be registered and processed. For details regarding the transfer/registration/processing steps refer to Section 7 of this SOP.
- Once the SD card data transfer is complete it will then be put into its corresponding digital media envelope with a completed photo card sheet indicating the IR number, date of the scans, serial number of individual that took the scans, the SD card number, and indicate that these are “FARO RAW Data Scans”. The envelope will then be placed into the Digital Media Evidence locker identified for FARO data scans in order to be uploaded to the secured digital media server. An email will be sent to the Crime Scene Response Supervisors indicating that FARO data has been placed into the locker and needs to be uploaded to the secured digital media server. In the absence of a Crime Scene

Response Supervisor available to upload the data, the data can be turned over to the Forensic Imaging Unit (FIU) following these same guidelines.

(10)Freestyle 2 Operation

(a) Scanner Set-up

- The Freestyle 2 can be used for specific items as a stand-alone scan or utilized to scan finer details within a crime scene in conjunction with the Focus scanner.
- Insert the power block battery into the Mobile PC. Turn on the power to the Mobile PC by pressing the On/Off Button. The blue LED flashes during the booting process. The computer is ready when the On/Off button stops flashing and shows a constant blue light.
- Connect the shoulder strap to the Mobile PC for carrying the scanner at the scene. If preferred a belt clip can also be utilized to carry the scanner at the scenes. For specific instructions on how to attach the shoulder strap or belt clip refer to the Freestyle 2 User Manual.
- Remove the smartphone from the case and attach to the Freestyle 2 scanner handset. There is a metal plate attached to the back of the smartphone that will attach to a magnet on the scanner handset.
- Turn on the smartphone and connect to the scanner handset via the USB cable.
- Connect the scanner handset connector to the Mobile PC data and power socket. The plug will slide into the socket with gentle pressure when it is correctly aligned (do not force the plug into the socket as it could damage the connection).
- Start the Mobile PC by pressing the On/Off Button. The blue LED flashes during the booting process. The computer is ready when the On/Off button stops flashing and shows a constant blue light.
- Start the Freestyle 2 app on the smartphone. Tap the Enable USB button and the app will automatically redirect you to the right settings page. Choose USB, then return to the app. Note that you must do this step each time the phone is reconnected.
- The app connects automatically to the handset. The Freestyle 2 app starts with the home screen by default. The handset is ready to scan when the LED on the center button is blue.
- Check and adjust the recording settings before you begin to scan. The default values will work in many situations, but take note of what you can adjust, according to environment you are scanning and the results you want to get.

    i. **Data range**: A number between 1 m and 10 m (3 ft and 33 ft) can be entered. However, as a standard setting the data range should not be set higher than 6 ft. The Freestyle 2 will not record points that are

further away than this distance. Use this setting when you want to exclude unimportant objects from your scan.

ii. **Plane detection**: Switch on when scanning an area with flat surfaces. When scanning in areas without flat surfaces, scanning without plane detection may lead to a slightly better performance.

iii. **Color Scan**: This should be switched on for most scans unless a grayscale is preferred.

iv. **Flash**: Use this to switch the flash on and off. Note that you can also switch the flash on and off while scanning by using the handset buttons.

- The white balance can be adjusted on the device when accurate color in scans is important to the information being captured.
- The white balance should be adjusted right before scanning, or whenever the amount or type of light changes

(b) Scanner Operation

- Create a scan project.

i. Tap Scan Projects on the smartphone interface screen.

ii. Tap Add Project.

iii. Enter a project name- This will include the IR number_A # and the specific area (including address) or item being scanned.

1. Example: 202100001234567_A1234_Nissan Altima AZ ABC-123

iv. Tap OK. The project is created.

v. Tap home icon to return to home screen

- Prior to performing scanning of the area to be captured you should complete the on-site compensation of the handheld scanner utilizing the included reference plate. This compensation would only need to be done once at a crime scene prior to completing the scans regardless of how many scans were completed within the project. Compensation involves capturing the reference plate from different angles and at different heights

i. Remove the reference plate from the Freestyle 2 kit and note the number on the back of the plate as you will need that number later in the procedure.

ii. Place the reference plate on a flat, stable surface, for example, the floor. The markers must face upward and each marker must be visible.

iii. Ensure that the reference plate is well illuminated.

iv. Ensure that the reference plate is not covered by hard shadows. This may happen easily, so check in advance if parts of your body, Freestyle 2, or something else could produce a hard shadow on the reference plate during the compensation procedure.

v. With the handset switched on and the app started, select **Tools > On-site Compensation**

vi. Enter the reference plate's number (leaving out "CP" and any leading zeros) and tap the **OK** button.

vii. The start window of the compensation is displayed. Start compensation by tapping **Start on-site compensation**, and then pressing the middle button on the Freestyle 2 handset.

viii. The handset now starts to capture. You will see a stylized view of the reference plate, a drawing of the handset, and a diagonal line representing the approximate place and angle at which you should hold the handset in relation to the reference plate.

ix. Hold the handset above the reference plate. When the handset starts scanning the plate, an animation on screen will show you the appropriate position of the handset in relation to the reference plate.

x. Move the handset so that it is scanning at the angle shown by the blue line, and from the height represented by the blue dot. A black band across the background of the animation will turn gray when you have the proper height. Note that the white line illustrating the scanning angle does not have to match up with the blue line--it only needs to be parallel to it as long as the scanner is still scanning the reference plate. A white arrow may appear to tell you the direction that you need to rotate the handset to get the correct angle. When the position of the handset is correct, the red 4 on the right side of the screen will turn green and quickly count down to 0. If the handset remains in the correct position during the countdown, then a green circle with a check mark will appear at the first compensation position, and the second position will appear.

xi. Repeat the step above for all compensation positions.

xii. When the rotational compensation is complete, the vertical compensation begins.

xiii. For the vertical compensation, a vertical bar with a drawing of the handset is shown at the left, together with a vertical line and a measurement showing an approximate height from the reference plate.

xiv. Hold the handset directly and horizontally over the reference plate. A black band across the background of the animation will turn gray when you have the proper height. Note that the white line illustrating

the scanning angle does not have to match up with the blue line--it only needs to be parallel to it as long as the scanner is still scanning the reference plate. A white arrow may appear to tell you the direction that you need to rotate the handset to be perpendicular and parallel to the reference plate. When the position of the handset is correct, the red 4 on the right side of the screen will turn green and quickly count down to 0. If the handset remains in the correct position during the countdown, then a green circle with a check mark will appear at the first compensation position, and the second position will appear.

xv. Repeat the step above for all compensation positions.

xvi. As soon as all positions have a green check mark the calibration of the device is checked, and, if necessary, adjusted. After that, on-site compensation is finished.

xvii. A compensation report is saved as a PDF file. You can find it in your scan project folder, in a subfolder called "**compensationReports**". The Compensation report states whether the on-site compensation was successful, and it shows some important data including the information below which may be necessary for verification of accuracy.

- Plan how you will scan the objects of interest before you begin, taking the following recommendations into consideration:

i. The longer a single scan takes, the longer the processing time will be. Try to keep scan times as short as possible—under 5 minutes is best. It is better to have one scan that captures all objects of interest than to have several scans. Fewer scans mean less registration.

ii. Move the handset slowly and constantly, avoid jerky movements. Fast and jerky movements may lead to inaccurate data or tracking may be lost. Accuracy and tracking may be improved if you avoid excessive twisting movements while scanning.

iii. Make sure that the objects of interest are within the specified maximum range and minimum range of the handset.

iv. Objects or surfaces may have an increased noise or reduced data if they are directly illuminated by bright sunshine.

v. Use markers for high accuracy tasks. If the number of features is low or badly distributed, try to move the handset's field of view to areas with more structures. Scanning areas with few features or without texture can be difficult. Add markers or other artificial targets for better results.

vi. If the lighting conditions are bad, use the flashlight or other portable lighting to get better results.

vii. If you are not able to scan dark areas, the area may be treated with developer spray.

viii. If you are not able to scan shiny areas, the area may be treated with developer spray. Try to move the handset in circles or loops. This helps with loop-closing.

ix. When scanning all sides of an object, start and stop at “less interesting” positions. For example, when scanning a person, start and stop at the back.

x. Try to finish a scan at the place where you began. This helps with loop-closing.

xi. Objects must not move while they are captured.

- If the scan from the Freestyle 2 is to be registered with other Focus scanner scans, ensure that markers are placed out that both the Freestyle 2 and the Focus scanner can visualize in order to properly register the scans together.
- Start capturing the area to be scanned by pressing the blue “Play” button on the smartphone interface screen.
- When scanning a vehicle with the Freestyle 2, the following are recommendations to improve the overall scan of the vehicle:
    i. Try to maintain a standoff distance from the vehicle of 4.5 ft to 6 ft when possible.
    ii. When scanning the interior of the vehicle set the capture distance setting to 5 ft..
    iii. Scan the markers and reference plate from a distance of 1 ft. to 3 ft.
    iv. Keep the flash on during the scans.
    v. Process the files on a computer for best results.
- Once the scans have been completed the scan data will need to be exported from the scanner utilizing a USB thumb drive or other portable hard drive.
    - To export the data, follow these steps:
        - Insert USB flash drive in the Mobile PC.
        - From the projects view, tap **Select**.
        - Tap the project you want to export to select it.
        - Tap **Export**. The project will be exported to the USB flash drive as: /Exported_Projects/ProjectName
- Once the data is exported to a USB thumb drive, it should then be transferred to the Faro laptop in order to be registered and processed. For details regarding the transfer/registration/processing steps refer to Section 7 of this SOP.

- After the transfer of data the USB thumb drive will then be put into a digital media envelope with a completed photo card sheet indicating the IR number, date of the scans, serial number of individual that took the scans, and indicate that these are "FARO RAW Data Scans". The envelope will then be placed into the Digital Media Evidence locker identified for FARO data scans in order to be uploaded to the secured digital media server. An email will be sent to the Crime Scene Response Supervisors indicating that FARO data has been placed into the locker and needs to be uploaded to the secured digital media server. In the absence of a Crime Scene Response Supervisor available to upload the data, the data can be turned over to the Forensic Imaging Unit (FIU) following these same guidelines.

- it will be placed into the Digital Media Evidence locker identified for FARO data in order to be uploaded to the secured digital media server. An email will be sent to the Crime Scene Response Supervisors indicating that FARO data has been placed into the locker and needs to be uploaded to the secured digital media server. In the absence of a Crime Scene Response Supervisor available to upload the data, the data can be turned over to the Forensic Imaging Unit (FIU) following their guidelines.

(7) Scanner Data Registration/Processing

(a) Focus Scanner S150

- After the SD card has been removed from the scanner it needs to be transferred to the Faro laptop. Once transferred the data will need to be registered and processed by the CSS utilizing the SCENE software.
- Make sure you insert the USB dongle license for the SCENE software into the laptop prior to opening the program.
- Open SCENE and configure the processing and registration settings for your project.
    - The processing and registration settings should be set to the necessary default settings, however they can be modified based upon the project needs.
- Insert the SD card containing the scan project.
- A dialog box will prompt you to import the scans. Click **Yes**.
- On the **Configure Process Transfer page**, select **Transfer** and **Process** for all of the projects you want to transfer.
- Click **Start Transfer**.
- The selected projects will be transferred and processed.
- If you get a screen that says processing failed it is likely that the SCENE could not register the scans on its own. This could be for a couple of different reasons:
    - There may not be enough overlap between the scans.

  - The surfaces in the scene may be difficult to register, like blowing trees and tall grass.
  - Rooms or surfaces in one area of the scene may look similar to other areas in the scene which can throw off registration. Mirrors in the scene could duplicate a room.

- Process the scans after the project has been transferred.
- Open the project.
- Click **Project** on the SCENE ribbon.
- Click **Process Scans** under **Processing**.
- Select the scans to process and click **Configure Processing**.
- Adjust the processing settings as desired.
- Click **Start Processing**.
- Verify the registration of the scans that were imported. Even if the scans registered successfully during the project transfer, you will need to view and verify the registration.
- On the project page, click **Registration** to check.
- Click **Verify Registration** or the Scan Report icon.
- On the **Register and Verify** page, use the view toolbar at the bottom to compare your scans from different angles.
- If the scans are registered correctly, click **Yes** and **Finish**.
- If not, click **No** and **Finish**. You will be directed to register the scans again.
  - If automatic registration failed, you will need to utilize either visual or manual registration within the SCENE program.
  - Visual registration allows for the manual placement of the scans
  - It is recommended to use scan point clouds as you can see all the data at once when moving the scans around interactively.
  - Manual registration allows correspondence between two sans by picking scan points
  - As soon as there are sufficient corresponding scan points, SCENE will register the two scans.
- You can register scans later, by clicking the **Registration** tab on the SCENE ribbon.
- As changes are made to the scans as they are processed and examined be sure to save your work and save it often. There is no undo button and if something needs to be changed it will revert back to the last hard save that was created.

  - Comments should be made in the Save dialog box in order to indicate what changes have been made to the scan data as you work on the data.

- The working scan data will be saved on the Faro laptops under the file location, D:\Scan Data\.
- A Scene2Go project as well as the 3D point cloud data will be created within the SCENE software as part of the completion of the scan project and saved to the same IR folder that was created within the D:\Scan Data\ file location. A separate folder with the name Scene2Go should be created under the IR number file folder and the created Scene2Go project saved to that specific folder. Additional items may be created and saved at the time of the completion of the scan project at the discretion of the CSS or at the request of the case agent (e.g. Orthographic photos, overview maps, etc.).
- Once the scan project has been completed with the necessary information, the IR number folder should be saved to a portable digital media storage device (e.g. SD card, thumb drive, portable hard drive, etc.) and then submitted through the same submission process as the RAW data scans, with the exception that a new photo card will be completed with the necessary information and indicating that these are “FARO 3D Data Scans” in order to be uploaded into the secured digital media server for available viewing by our investigative partners. If the data file is too large to be put on a smaller portable storage device such as a SD card or USB thumb drive and needs to be put on a portable hard drive, which will not fit in the digital media envelopes, you will turn it directly over to a Crime Scene Response Supervisor for uploading. Additional enhancements and deliverables can be created utilizing the data as requested by the case investigator, such as video fly throughs, measurements, point clouds, 2D/3D diagrams, trajectory analysis, etc.
- Once the scan project has been completed the case agent should be contacted to arrange to come obtain a copy of the Scene2Go file folder that was created as part of the scan project, which they can use for their investigative purposes.

(b) Freestyle 2 Scanner

- The USB drive or portable hard drive, once the RAW scan data is uploaded to the secured digital media server, will be returned to the CSS for registration and processing of the scans completed at the crime scene.
- Insert the USB drive or portable hard drive into the Faro laptop and ensure you have the SCENE USB license dongle inserted into the laptop as well.
- Open the SCENE program.
- Click **Process Handheld Scans** on the **Processing** ribbon.
- Select the scans or scan cluster.
- Click **Configure Processing**.

- Configure scan processing options, if needed. The processing settings should be set to the default and will be acceptable for most processing but may need to be changed based upon the scan project completed.
- Click **Start Processing**.
- Click **Ok** when processing is complete.
- When the project processing is complete, you will need to register the scans in your project if it contains more than one.
- Select the **Registration** tab.
- Select **Automatic Registration with targets**.
- Select the scans cluster.
- Click **Select Method** and adjust settings as necessary
- Click **Register and Verify**. If the registration is not successful, try manual registration instead.
- The scans from the Freestyle 2 should be incorporated into the Focus scans that were created to create one complete scan project.
- If the Freestyle scans were completed as a stand alone project and will not be incorporated into the Focus scans then refer to the Focus Scanner S150 section of Section 7 of this SOP regarding what needs to be completed with the finished scan project.

D. Calibration/Maintenance

(1) While under service contract, the vendor shall be responsible for preventative and corrective maintenance on an annual interval to include, but not limited to:

(a) **Updates and Upgrades**

- Thorough internal and external cleaning
- Comprehensive, automated, 650-700 line-item self-diagnostic test
- Electronic sensor adjustment
- Wireless connectivity test
- Compass test
- Altimeter test
- GPS test when applicable
- Accuracy test
- Update to current version of firmware

(b) **Measurement and Adjustments of Internal Components**

- Distance sensor
- Intensity sensor
- Angular sensors
- Temperature sensors if internal components are replaced
- Touchscreen
- Color camera
- Inclinometer
- Final consistency check

(c) **Calibration**

- Full calibration to meet factory specifications
- New certification certificate

(2) Laboratory Services Bureau personnel may, as needed, perform general maintenance to include cleaning slightly contaminated optics as well as performing scan accuracy checks utilizing the NIST certified scale bars.

(a) Scan accuracy checks should be completed after the scanners have been returned from any vendor maintenance or calibration.

(3) While under service contract, all software and firmware updates will be installed as received by the vendor.

E. Safety

(1) Focus S150 Laser Scanner

(a) In the interest of safety, the laser scanner and its accessories should only be used by competent, suitably trained operators after they have read and/or understand the equipment user manual and have considered any hazard involved.

(b) Do not expose the FARO Laser Scanner and its accessories to extreme temperatures. The ambient temperature for normal operation of the scanner should be between 41° F and 104° F, with an extended ambient temperature range between -4° F and 131° F, however a thermal protection cover is required for the extended operating temperature range.

(c) Do not immerse the FARO Laser Scanner and its accessories into water. Liquid in the product enclosure can lead to damage, fire, or electric shocks.

(d) Do not use the FARO Laser Scanner and its accessories in an explosive atmosphere. Do not operate the instrument in the presence of flammable gases or fumes.

(e) The FARO Laser Scanner may only be used when set on a flat and stable surface. Injuries may result if the FARO Laser Scanner overturns. Only use equipment

recommended by FARO and follow the setup instructions in this SOP or in the user manual of the manufacturer of the equipment.

(2) Freestyle 2 Handheld Scanner

(a) In the interests of safety, the devices should only be used by competent, suitably trained users after they have read and understood the equipment user manual and considered any hazard that might be involved.

(b) The Freestyle 2 is classified as a class 1 laser in accordance with IEC 60825-1:2014 (ed. 3).

(c) Freestyle 2 is safe under reasonably foreseeable conditions of operation. The maximum permissible exposure (MPE) cannot be exceeded. It is harmless to the eyes if it is used and maintained in accordance with the instructions in the equipment user manual.

(d) Do not expose the devices to extreme temperatures. The ambient temperature must not be lower or higher than given in the specifications.

(e) Do not expose the devices to water, including rain. Liquid in the product enclosure can lead to damage, fire, or electric shocks.

F. References

(1) SCENE 2020 FARO Focus Laser Scanners Training Workbook, December 2020

(2) FARO Focus Laser Scanner User Manual, February 2020

(3) FARO Focus Laser Scanning Best Practices, March 2021

(4) FARO Freestyle 2 User Manual, August 2020

(5) FARO Scanning Best Practices with the Freestyle 2, March 2021

(6) FARO Scanning Vehicles with the Freestyle 2, March 2021

(7) Additional references and tutorials can be viewed at the following link, https://knowledge.faro.com